European Journal of Engineering Education

Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/ceee20

Design of an integrated team project as bachelor thesis in bioscience engineering

Marie-Christine Peetersa[a], Elsje Londers[b] & Wouter Van der Hoeven[a]

[a] Teaching Support Unit, Faculty of Bioscience Engineering, KU Leuven, Kasteelpark Arenberg 21, B-3001 Leuven, Belgium

[b] Administrative and Support Services, Faculty of Engineering Science, KU Leuven, Kasteelpark Arenberg 1, B-3001 Leuven, Belgium

Published online: 25 Mar 2014.

To cite this article: Marie-Christine Peetersa, Elsje Londers & Wouter Van der Hoeven (2014): Design of an integrated team project as bachelor thesis in bioscience engineering, European Journal of Engineering Education, DOI: 10.1080/03043797.2014.899322

To link to this article: http://dx.doi.org/10.1080/03043797.2014.899322

European Journal of Engineering Education, 2014
http://dx.doi.org/10.1080/03043797.2014.899322

Taylor & Francis
Taylor & Francis Group

Design of an integrated team project as bachelor thesis in bioscience engineering

Marie-Christine Peeters[a]*, Elsje Londers[b] and Wouter Van der Hoeven[a]

[a]*Teaching Support Unit, Faculty of Bioscience Engineering, KU Leuven, Kasteelpark Arenberg 21, B-3001 Leuven, Belgium;* [b]*Administrative and Support Services, Faculty of Engineering Science, KU Leuven, Kasteelpark Arenberg 1, B-3001 Leuven, Belgium*

(*Received 5 November 2012; accepted 20 February 2014*)

Following the decision at the KU Leuven to implement the educational concept of guided independent learning and to encourage students to participate in scientific research, the Faculty of Bioscience Engineering decided to introduce a bachelor thesis. Competencies, such as communication, scientific research and teamwork, need to be present in the design of this thesis. Because of the high number of students and the multidisciplinary nature of the graduates, all research divisions of the faculty are asked to participate. The yearly surveys and hearings were used for further optimisation. The actual design of this bachelor thesis is presented and discussed in this paper.

Keywords: bachelor thesis; project work; multidisciplinary; team work; coaching

1. Introduction

The Faculty of Bioscience Engineering (BSE) at KU Leuven has a long history. At the end of the nineteenth century, there was a need for new and more competitive production methods and the first agricultural engineers graduated at the faculty of agricultural engineering. After World War II, a large number of agricultural and bio-industrial companies were founded and there was a need for a scientific approach and diversification of the educational programme. The education is not only focused on knowledge but also on the explanation of the processes and application of biological phenomena (Suckers 2008).

In 1991, the Bologna declaration was signed by 29 European countries to reorganise the higher education to a common and open European education. Each country retained its sovereignty to adapt this Bologna process resulting in considerable differences in education policy in the participating countries. The German reading of the Bologna process has been extensively evaluated (Winkel 2010). In 1999, the KU Leuven decided to implement the educational concept of guided independent learning (GIL). The education must be scientifically substantiated and the students are encouraged to participate in scientific research. Learning objectives and outcomes of the different courses and educational programmes must be specified and the learning environment needs to be motivating, challenging and activating. Transfer of cognitive knowledge is no longer the most

*Corresponding author. Email: christine.peeters@biw.kuleuven.be

important task. Competencies, such as communicating, informing, doing research, designing, working in team, are integrated in the educational programmes (Serdons et al. 2006).

The KU Leuven continued to update its vision of teaching and learning (KU Leuven 2009). In 2004, the bachelor/master system was introduced. The education programmes are research-based, thus enabling students to acquire academic competencies, including thorough knowledge and skills in the discipline, coupled with a broader interdisciplinary perspective. In this vision of teaching and learning, the active student is at the end responsible for his/her own learning process. It is the responsibility of the staff to provide optimal support for the student during this process. At that time, the name of the faculty was changed to Faculty of Bioscience Engineering. The first four semesters are identical for all bachelor students; thereafter they need to choose out of seven disciplines (food technology, catalytic technology, environmental technology, cell and gene technology, land conservation, biosystems engineering and agricultural technology). The bachelor programme is multidisciplinary and the result is that all students graduate as bachelor in BSE.

In 2007, the educational commission decided to introduce the bachelor thesis in the curriculum. Regular surveys and hearings with students and coaches were used for updating. The actual design of this thesis is presented in this paper.

2. The bachelor thesis

To move from a traditional instructor-centred to a more student-centred model, the bachelor thesis was implemented in the BSE curriculum. The objective of the thesis is that the graduates develop a reflective and research attitude in a broader, multidisciplinary context.

Most literature on the bachelor thesis is related to nursing and teacher education (Meeus, Van Looy, and Libbotton 2004; Lundgren, Halvarsson, and Robertson 2008) and to quality in the supervision (Holmberg 2006).

Gavin (2010) presented a design for a Master of engineering programme in civil engineering to meet the Bologna requirements and to meet the specification of learning outcomes. This design and the generic list of competencies/outcomes are a well-documented and valuable source of inspiration to move to a student-centred model in an engineering curriculum.

Project-based education where teams of students work during a longer period together with a coach on a specified project gives the opportunity to work on these competencies (Dekeyser and Baert 1999). Project-based courses are common in computing education and have been studied extensively. Richards (2009) discussed the design considering type, length, size, management and composition of the groups. Out of the three types of project work, which were described by Kolmos (1996), the 'subject project' was selected as the model. The design of the here presented bachelor thesis is also related to the well-documented capstone course at the university of Houston (Bannerot, Kastor, and Ruchhoeft 2010).

3. Coached and integrated team work

This thesis needs to be project-based with emphasis on the multidisciplinary nature of the bachelor BSE curriculum. The title integrated team project (ITP) was given to the bachelor thesis and learning objectives, learning outcomes and evaluation methods were written (KU Leuven 2012).

After the start in 2007, surveys and hearings with students and coaches were held yearly and the information was used to adjust. The actual design is presented here.

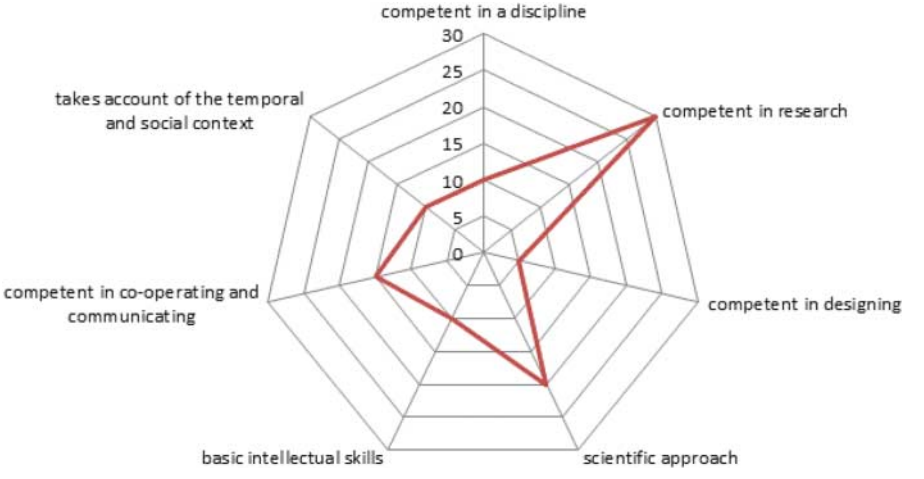

Figure 1. Competence profile of the bachelor thesis, ITP, at the Faculty of Bioscience Engineering. The radial axis is the percentage of time spent on developing a specific competence.

The increased focus on learning-oriented education provoked an increase in methodologies to specify learning outcomes. Academic Competencies and Quality Assurance (ACQA) is a method developed at the Eindhoven University of Technology (the Netherlands) to evaluate learning outcomes that can be used for accreditation and quality assurance (Meijers, van Overveld, and Perrenet 2007). A conceptual framework consisting of seven competence areas and a level-based description of the activities of analysis, synthesis, abstraction and concretisation is defined. Based on data collected from lecturers and programme directors, this conceptual framework is translated into competence profiles for a curriculum or course. This instrument is implemented by the Faculties of Engineering Science and Bioscience Engineering at KU Leuven to characterise engineering curricula (Berbers et al. 2011). As for the other courses, a competence profile for the ITP was constructed and visualised. Figure 1 indicates how the time spent on ITP has to be distributed over the seven areas of competencies of the BSE curriculum. Highest priority is given to being competent in research (30% of the time) and scientific approach (20% of the time). Communication and co-operation are also important (15%). These competencies received before the start of ITP little attention in the curriculum and were therefore included.

4. Implementation

The organisation of the ITP is done by a didactical team consisting of an independent coordinator and three professors, one out of the three different participating research departments. Communication with students and coaches is done by a university wide e-learning tool, Toledo (http://toledo.kuleuven.be/english/index.php).

4.1. *Collection of projects*

Although the size of the group can vary according to the educational goals, three is considered as a typical lower bound and seven as the upper bound. Five is often considered as a convenient group size (Nicolay 2002).

Each year, 150–200 students graduate as bachelor BSE at KU Leuven. Consequently, 30–40 different projects are needed every year. Therefore, all three research departments of the faculty,

i.e. the Department of Earth and Environmental Sciences (five research divisions), Department of Biosystems (five research divisions) and Department of Microbial and Molecular Systems (three research centres) were asked to participate. The supervisor completes an electronic form that includes a brief description, the name of the coach(es), the activities and at least three different disciplines for which the project can apply.

4.2. *Formation of the teams*

Formation of the teams is troublesome. One approach is that students form their own team resulting in homogeneous groups. However, it is argued that heterogeneous groups tend to function better as compared to homogeneous groups. Frequently, the differences in the timetable of the students can also be a critical factor in the functioning of the group (Richards 2009). The random assignment of students to teams can reduce the group effect, but this seems to be at odds with the efforts to get students more interested in the assigned group project (Zhang, Johnston, and Kilic 2008). There is clearly no general method to form teams in project-based learning (Richards 2009).

Teamwork is a vehicle to require skills of collaboration, communication and ability to work in teams, but this can produce problems with free-riding team members. Therefore, peer assessment is applied (Willey and Freeman 2006).

The list of all ITP projects with a short description becomes available at the beginning of the semester. After a lecture with all information on the learning objectives, timetable, activities and evaluation, the students select their project using an e-selection tool. To ensure multidisciplinary teams, the students of each of the seven disciplines use a separate selection tool. They can only select a project which is admitted for students of their discipline as indicated by the supervisors at the time of submission. For each of the selection tools, the number of choices is equal to the number of students in the discipline to ensure that all students have a project and the teams are complete. In this way teams of four to five students from at least two different disciplines are obtained. Some years the number of projects was enough to have group sizes varying from four to five students; other years, the number was lower resulting in larger group sizes.

4.3. *Coaching*

The coaching of the teams is done by research assistants of the different research divisions. Most of them are preparing for their PhD. There is a large turnover in assistants and they have little or no experience in coaching. There is no time and actually there are no means at our faculty to professionally train them. At the start of the projects, all the coaches are invited for an informative lecture followed by an interactive discussion. Recently, a coaching model was developed which gives the best coaching methods for each project based on its specific learning objectives (Van der Hoeven and Peeters 2013). This theoretical coaching model is available in an easy-to-use manual whereby the teaching team can determine the optimal coaching profile based on the characteristics of their project. For each of the profiles, the necessary information and guidelines to take on these coaching roles are given.

In Toledo, the students and coaches can find all information and instructions concerning the bachelor thesis. Each team also has a private group page to which only the members of the team have access and where they can manage and share documents, organise a discussion forum and easily send group mails.

Immediately after the teams have been formed, the group makes a first appointment with the coach. From then on, each team works independently on the project with their own coach. The number of meetings can vary; at least three meetings in the presence of the coach are recommended. Several links to websites with information on the organisation of effective meetings are given. For

each meeting, the group indicates a chairman and secretary. A short meeting report is posted on the group pages where the students write down the decisions and agreements made during each meeting. The group also keeps a logbook on the group pages where they write down their reflections on the different competencies which were used and developed during the meetings. The instructions and manual for this logbook are available on Toledo and the logbook is also posted there.

4.4. *Products*

The bachelor thesis at BSE mainly focuses on three areas of competencies (Figure 1). The learning outcomes of these competencies are communicated to the students and coaches and can be found in the manual of the logbook available in Toledo.

During the activities of the project, it is important that these competencies are reflected in the learning outcomes and products. The coaches carefully observe the process activities of their team during the whole project and to evaluate this they have access to their meeting reports and logbook.

Each team has to write a scientific paper and prepare a scientific poster. Links to relevant websites and instructions to write a scientific paper and to prepare a poster are given. For the poster, the groups have to use the template which is provided in Toledo. For the paper, the students have to use a model of a reviewed journal in the field of their project. Both products are submitted to Toledo before a certain deadline, which is communicated at the start of the project.

4.5. *Evaluation*

For the ITP projects, a group score is given based on the process, paper and poster evaluation.

The process assessment is done by each of the coaches and they evaluate the soft competencies (Powell 2004). The papers are assessed by a team of 10 evaluators, the three coordinating professors and seven teaching assistants. The papers are randomly divided in such a way that each paper is evaluated three times. At the end of the semester, a poster exhibition is organised. Each poster is then evaluated by three different juries to give an average score for each poster. The juries are multidisciplinary and consist of lecturers, professors or research assistants of the three different research departments of the faculty BSE. After a short presentation, the group of students is questioned by the different members of the jury. Each jury reaches an agreement for a final score for each poster they had to evaluate. Care is taken to avoid that a coach will evaluate the poster of his team. For the process, paper and poster evaluation forms (Figure 2) are made and the completed forms are electronically submitted to the coordinator. All these forms become available as feedback for the students at the end of the academic year. The group score is the sum of the scores by the coach (40%) and the average score of the paper (30%) and poster (30%).

Different methods of assessing groups of students have been described (Lejk and Wyvill 1996). It is important that each student in a team will be rewarded for his efforts and that free-riders will not benefit from the work of other students. Different tools for peer assessment in group activities (Wenzel 2007; Cestone, Levine, and Lane 2008) have been discussed within the didactical team. Finally, the following system was used because this system is clear, facilitates differentiation within the group score and is easy to process. The rating was done electronically and was anonymous for the colleagues of the group. The criteria to be evaluated were the same as the criteria evaluated by the coach (Figure 2). For each criterion, the student has to rate the colleagues of the group by giving a score 0 in case the colleague was average, a score -1 for a student who was below average and a score $+1$ for a student who was above average. The sum of the scores for one criterion in a group needs to be around 0. If there is a student below average, then there also

PAPER (30%)	max
Content	
complete	10
correct use of concepts	10
logical structure	10
original	10
clear	10
Style and structure	
syntax	10
scientific style	10
scientific language	10
References	
up-to-date	10
used in the correct way	10
the list is complete	10
TOTAL	110

POSTER (30%)	max
content	10
structure	10
layout	10
responding the questions	10
global presentation of poster	10
interaction between students	10
TOTAL	60

PROCESS (40%)	max
activity	10
creativity/inventivity	10
logbook	10
keeping the engagement	10
group atmosphere	10
TOTAL	50

Figure 2. Evaluation form for the paper, poster and process.
Note: Score > 9: excellent; 8–9: very good; 6–8: good; 5–6: moderate; 4–5: weak and < 4: very weak.

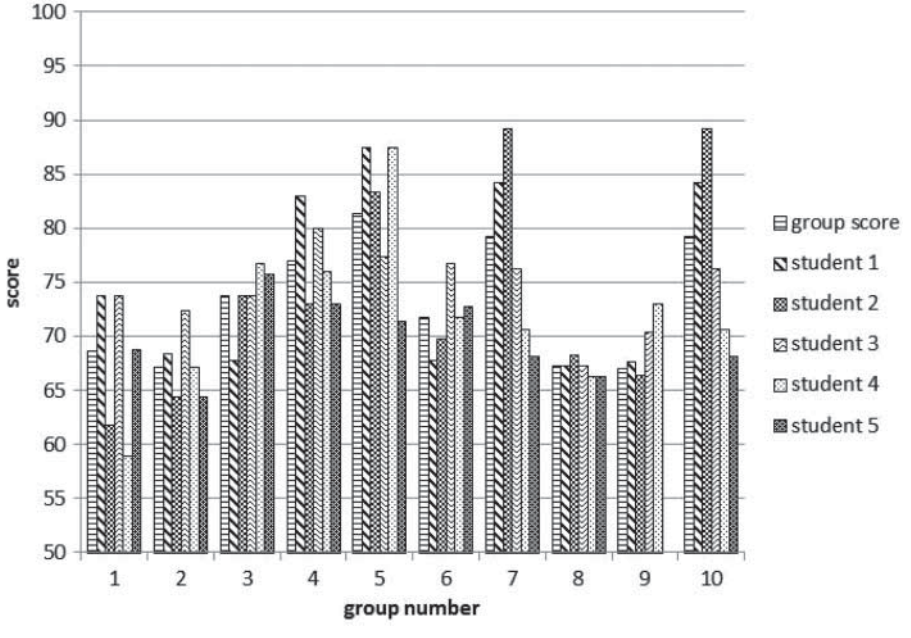

Figure 3. Differentiation of the group score in 10 different groups of ITP in 2012. The group score was adjusted by the results of a peer assessment.

needs to be a student above average. In a group with six students, the worst (best) case is that a student receives a score $-1(+1)$ for all five criteria of the five colleagues giving a total of -25 $(+25)$. At the beginning of the project, it is well communicated to the students that the groups score is then reduced (increased) by 20%. The students are familiar with this rating system since

it is used in another course with group activities in their curriculum. This method differentiates the group score; the free-riders will be fined and diligent students will be rewarded (Figure 3).

5. Evaluation of the design by the students

Over the past five years, project-based learning has been implemented in the bachelor thesis of our faculty and nowadays it plays a pivotal role in the curriculum. During the poster session, the students are asked to fill in an electronic Likert-scale survey (Trochim 2006). This survey is anonymous and the results are used to evaluate the design and to make adjustments if necessary. The results are presented in Figure 4. In addition, the students were asked to define the strong and weak points, and to give the total number of hours they spent on the project.

The students are satisfied to very satisfied about the design of the bachelor thesis. They really appreciate working with the same coach throughout the whole project. The scoring on the multi-disciplinary nature was still good, but for some students this was less pronounced. The use of a group score which is then differentiated by means of a peer assessment is considered to be fair to very fair. Almost 80% of the students agreed that the poster exhibition is an added value for the bachelor thesis.

In 2011, the students spent 52 ± 29 hours on this project work. This is much lower than might be expected (100–125 hours). Therefore, an appeal was made to the coaches to implement practical

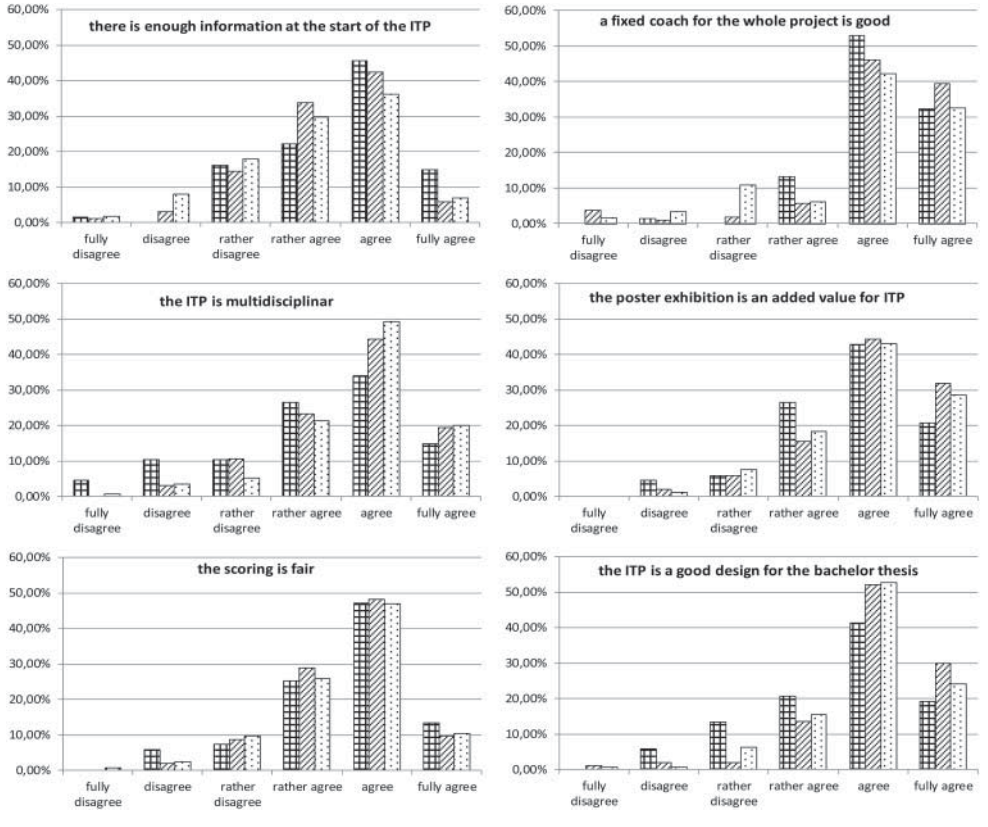

Figure 4. Results of a Likert-scale survey on the design of the ITP by the students in 2009 (138 students or 85%), 2012 (102 students or 63%) and 2013 (174 students or 99%).

work. The type of practical work is indicated in the electronic submission form to inform the students. This practical work can be experimental work in the research department, a survey, a visit to a company or institution. In 2012, the students spent 79 ± 45 hours, a vast increase but still below the expectations.

The most common strengths and weak points are summarised hereafter:

Strengths:

- the coaching is good to very good;
- the poster exhibition is fascinating and gives the opportunity to get to know the work of colleague students;
- teaming of students from different disciplines is exciting and instructive.

Weak points:

- there are differences in coaching and time management between the teams;
- the selection procedure for the projects: some students had no choice anymore;
- the limitation of eight pages for the paper.

6. Evaluation of the learning outcomes

A Likert-scale survey was done to assess the impact of the ITP on the competence profile of the BSE curriculum (Figure 5). The expected learning outcomes were specified and communicated to the students and coaches.

- is competent in research: can acquire new scientific knowledge by doing research.
- has a scientific approach: can use and develop theories and models and give interpretations and has a critical attitude.
- is competent in co-operation and communication: can work with and for others, can interact with others and has responsibility and leadership.

There was a very good agreement in the perception of the students and coaches. Co-operating and communication were the competencies which received the most attention. The other important competencies which were aimed at the bachelor thesis, i.e. competent in research and scientific approach, also scored well. Since these competencies received little attention in other courses of the curriculum, the educational commission was very pleased with the results of the survey. A good perception was also observed for the other competencies (Figure 1) in the profile of bachelor BSE.

7. Discussion

To stimulate the development of some competencies which are characteristic for bioscience engineers, the the educational commission decided to implement a bachelor thesis. The objectives, learning activities and outcomes were defined based on the educational approach 'GIL' and the ACQA methodology. The result is a project-based course 'ITP' with emphasis on research and communication/co-operating competencies.

Because of the high number of teams and the multidisciplinary nature, it was clear that such a project is only feasible with the support of all research units of the faculty. At the beginning this was a bottleneck and it was sometimes necessary to work with large teams. Some of the students who attended ITP in the initial phase are now research assistants and they are very motivated to coach projects. The number of projects is now high enough to work with teams of four students.

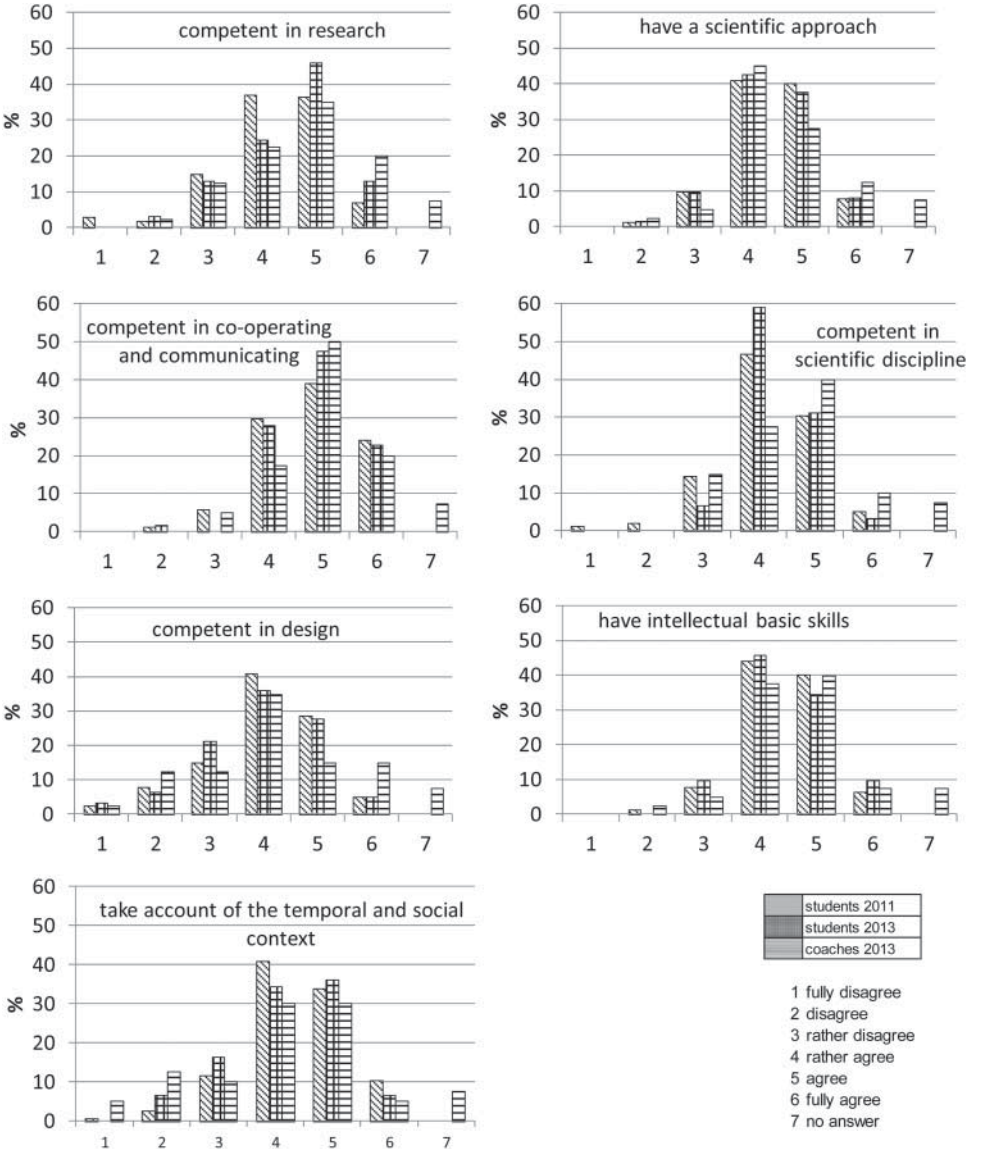

Figure 5. Results of a Likert-scale survey of the students in 2011 (155 students or 95%) and of students (61 students or 35%) and coaches (40 or 93%) in 2013 to the question 'to what extent the different ACQA competences were developed during the project work?'

The surveys revealed that the students spend an average of only 65% of the time available on their project work. The educational commission therefore appeals to emphasise more on the research activity and to implement also practical work. This can be a lab experiment, field work or a survey. The poster evaluation also took into account the multidisciplinary character. Each jury consists of members of all three research departments and each member evaluates the poster based on his expertise. It would be interesting to analyse the learning outcomes of this additional practical work and multidisciplinary approach.

The electronic selection procedure for a project is such that the size of the teams is fixed and students of two to three disciplines out of the seven are mixed into one group to stimulate the

multidisciplinary approach. A criticism of the students is that students who have later access to the e-selection tool have less or no opportunity to choose a project. The didactical team, however, persisted in this selection procedure because of the multidisciplinary nature of the graduates. By the evaluation and during the poster exhibition, several students told that they were initially not happy with the assigned project. But finally they admitted that it was a very engaging experience to work with students of different disciplines on a theme that was not so related to their discipline.

The coaching of the projects is done by research assistants of the different departments. They do not teach and are rarely involved with education. They are appointed by the supervisors of their research unit who submit the projects. There is a great turnover and variation in coaches: junior and senior research assistants, postdocs and coaches of different nationalities. There is no time nor means to professionally train them and there is a lack of ready-to-use manuals. For the students, the difference in coaching was one of the weak points of the ITP. A research project was started to provide the coaches with the necessary support and guidance and a coaching tool was developed that maps the relationship between the key factors coaching, learning objectives and learning outcome (Peeters and Van der Hoeven 2012). Recently, a manual and web application to be used in educational practice have been presented (Van der Hoeven and Peeters 2013).

The assessment of the ITP was discussed within the didactical team and was experienced to be troublesome. The coaches of team-based work know what has been done, but it is tricky to be a facilitator and judge at the same time. In addition, there are two types of examinees: the student team and the individual student (Powell 2004). It was decided that the coaches evaluate the soft competencies which are difficult to assess in a formal examination. Because the contact moments are limited, the process was evaluated for the group, not the individual students. The coaches were attentive and in case of free-riding, the person in question was reprimanded. As feedback, the completed evaluation forms will become available for the students after the examination period. To reduce the subjectivity of the examination, a team of faculty researchers examines the final poster and paper. Initially, each paper or poster was examined by a single examiner or jury. Because of the great variation in the scores, each paper/poster is now evaluated by three independent examiners/juries to average the score. Each jury consists of members of all three different research departments to obtain a multidisciplinary evaluation. The completed evaluation forms for the poster/paper can also be consulted by the students. The poster examination at the end of the academic year takes place in the library and is now an instructive event where students and teachers meet and have exciting discussions.

For the process, paper and poster evaluation, forms have been made so that all evaluators and juries use the same criteria. Initially, there was a great variation in the scores. Hearings with evaluators revealed some discomfort and therefore an evaluation scale was added to the template. To facilitate the scoring and to avoid too large differences between the scoring of different reviewers and juries, an evaluation scale is given for a maximal score of 10: > 9 is excellent, 8–9 is very good, 6–8 is good, 5–6 is moderate, 4–5 is weak and < 4 is very weak.

The surveys show that students find the scoring to be fair and that students and coaches agree that the aimed competencies have been assessed. However, hearings with some students revealed that the students were not so familiar with the definition of the competencies. Doing experimental work in a lab was for many students equivalent to doing research. The relation competencies and learning outcomes in ITP clearly need to be further elaborated in this ITP. Strategies and tools to assess learning outcomes in higher education are well documented (Dodridge 1999; Hartel and Gardner 2003).

It is realised that there is still some work to do to improve the assessment. Recent discussions with supervisors of master thesis revealed that the students who followed ITP are better prepared than students who graduated some years ago and did not follow ITP. In-depth research on the learning outcome is recommended.

The students take no direct part in the examination. Initially, the posters were also assessed by the students. Conclusion was that students report higher marks compared with teachers and this is in agreement with other studies (Billington 1997; De Grez, Valcke, and Roozen 2012). To encourage the students to look at the posters of their colleagues during the exhibition, a small contest is organised. Each student can nominate the best poster for three different criteria: content, structure and layout. At the end of the poster exhibition, the posters with the highest number of nominations are proclaimed. The students really appreciated this and they were motivated by this competition to get to know the work of their colleagues.

To take into account the contribution of each student to the group activity, a peer assessment was done where students evaluate each colleague of the group. Different methods of assessing groups have been described (Lejk and Wyvill 1996; Wenzel 2007; Cestone, Levine, and Lane 2008). Initially, the students were asked to give a numeric score, but it was clear that the students use different standards to rate and some favouritism was involved. In addition, it was not obvious how to implement these ratings to differentiate the group score. The peer assessment is done by giving an evaluation of average, less than average or more than average for a number of criteria to each colleague student of the group. Initially, the individual score was determined as the group score $\pm$ max 10% calculated from the peer assessment. Because this resulted in little differentiation and there were still free-riders who benefit from the work of their colleagues and passed, the impact of the peer assessment was increased to $\pm$ max 20%. The coaches still remain attentive for free-riders and if necessary intervene on time. The students found this way of scoring fair to very fair and there were no complaints on free-riding.

Acknowledgements

The authors thank the students, colleagues and coaches of the Faculty of Bioscience Engineering for their contributions in the development of this project work. They are very grateful for the assistance of Anneleen Claassen (Teaching & Learning Department – Educational Development Unit, KU Leuven) with the revision of the manuscript. They acknowledge the colleagues of the Leuven Engineering and Science Education Centre for their instructive discussions on project work.

References

Bannerot, R., R. Kastor, and P. Ruchhoeft. 2010. "Multidisciplinary Capstone Design at the University of Houston." *Advances in Enigenering Education* 2 (1). http://advances.asee.org/wp-content/uploads/vol02/issue01/papers/aee-vol02-issue01-p04.pdf

Berbers, Y., M. P. Buyse, E. Froyen, and E. Londers. 2011. "ACQA: An Instrument for Accreditation and Quality Assurance in Engineering Curricula." Proceedings of the SEFI 2011 Annual Conference, SEFI 2011 Annual Conference, Lisbon, September 27–30.

Billington, H. 1997. "Poster Presentations and Peer Assessment: Novel Forms of Evaluation and Assessment." *Journal Biological Education* 31 (2): 18–22.

Cestone, C., R. Levine, and D. Lane. 2008. "Peer Assessment and Evaluation in Team-Based Learning". *New Directions for Teaching and Learning* 116: 69–78. doi:10.1002/tl.334.

De Grez, L., M. Valcke, and I. Roozen. 2012. "How Effective Are Self- and Peer Assessment of Oral Presentation Skills Compared with Teachers' Assessment?" *Active Learning in Higher Education* 13 (2): 129–142.

Dekeyser, L., and H. Baert. 1999. *Projectonderwijs: Leren en Werken in Groep*. Leuven: Acco.

Dodridge, M. 1999. "Learning Outcomes and Their Assessment in Higher Education." *Engineering Science and Education Journal*, 8 (4): 161–168.

Gavin, K. 2010. "Design of the Curriculum for a Second-Cycle Course in Civil Engineering in the Context of the Bologna Framework." *European Journal of Engineering Education* 35 (2): 175–185.

Hartel, R., and D. Gardner. 2003. "Making the Transition to a Food Science Curriculum Based on Assessment of Learning Outcomes." *Journal of Food Science Education* 2 (2): 32–39.

Holmberg, L. 2006. "Coach, Consultant or Mother: Supervisor's Views on Quality in the Supervision of Bachelor Theses." *Quality in Higher Education* 12 (2): 207–216.

Kolmos, A. 1996. "Reflections on Project Work and Problem-Based Learning." *European Journal of Engineering Education* 21 (2): 141–148.

KU Leuven. 2009. *University's Vision on Teaching and Learning.* Copyright © Katholieke Universiteit Leuven. Accessed September 20, 2013. http://www.kuleuven.be/education/KULeuven-Vision_of_teaching_and_learing-2009.pdf

KU Leuven. 2012. *Integrating Team Project*. Copyright © Katholieke Universiteit Leuven. Accessed September 20, 2013. http://onderwijsaanbod.kuleuven.be/syllabi/n/I0N41CN.htm
Lejk, M., and M. Wyvill. 1996. "A Survey of Methods of Deriving Individual Grades from Group Assessments. *Assessment & Evaluation in Higher Education* 21 (3): 267–281.
Lundgren, S. M., M. Halvarsson, and B. Robertson. 2008. "Quality Assessment and Comparison of Grading Between Examiners and Supervisors of Bachelor Theses in Nursing Education." *Nurse Education Today* 28 (1): 24–32.
Meeus, W., L. Van Looy, and A. Libbotton. 2004. "The Bachelor's Thesis in Teacher Education." *European Journal of Teacher Education* 27 (3): 299–321.
Meijers, A. W. M., C. W. A. M. van Overveld, and J. C. Perrenet. 2007. *Criteria for Academic Bachelor's and Master's Curricula*. Eindhoven, The Netherlands: Technische Universiteit Eindhoven.
Nicolay, J. A. 2002. "Group Assessment in the Online Learning Environment." *New Directions. Teaching and Learning* 91: 43–53.
Peeters, M.-C., and W. Van der Hoeven. 2012. "Development and Implementation of a Coaching Model for Project-Based Learning in Science and Engineering Education." Proceedings of the SEFI 2012 Annual Conference, SEFI 2012 Annual Conference, Thessaloniki, September 23–26.
Powell, P., 2004. "Assessment of Team-Based Projects in Project-Led Education." *European Journal of Engineering Education* 29 (2): 221–230.
Richards, D. 2009. "Designing Project-Based Courses with a Focus on Group Formation and Assessment." *ACM Transactions on Computing Education* 9 (1). doi:10.1145/1513593.1513595.
Serdons, I., M. Sintubin, M.-P. Buyse, and N. Toté. 2006. *Stap voor stap naar een stimulerende leeromgeving*. Leuven: Faculteit Wetenschappen KULeuven.
Suckers, M. 2008. *Geschiedenis van de faculteit Bio-ingenieurswetenschappen*. Copyright © KU Leuven. Accessed September 20, 2013. http://www.biw.kuleuven.be/algemeen/geschiedenis.aspx
Trochim, W. K. 2006. *Research Methods – Knowlegde Base – Measurements – Scaling – Likert scale.* Copyright ©2006, William M. K. Trochim. Accessed November 10, 2013. http://www.socialresearchmethods.net/kb/index.php
Van der Hoeven, W., and M.-C. Peeters. 2013. "The Development and Implementation of a Coaching Model for Project-Based Learning." Proceedings of the SEFI 2013 Annual Conference, SEFI 2013, Leuven, September 16–20. Accessed October 23, 2013. https://lirias.kuleuven.be/bitstream/123456789/416685/1/100.pdf
Wenzel, T. 2007. "Evaluation Tools to Guide Students' Peer-Assessment and Self-Assessment in Group Activities for the Lab and Classroom." *Journal of Chemical Education* 84 (1): 182–186.
Willey, K., and M. Freeman. 2006. "Improving Teamwork and Engagement: The Case for Self and Peer Assessment." *Australasian Journal of Engineering Education*. Online publication February 2006. Accessed October 23, 2013. http://www.aaee.com.au/journal/2006/willey0106.pdf
Winkel, O. 2010. "Higher Education Reform in Germany: How the Aims of the Bologna Process Can Be Simultaneously Supported and Missed." *International Journal of Educational Management* 24 (4): 303–313.
Zhang, B., L. Johnston, and G. B. Kilic. 2008. "Assessing the Reliability of Self- and Peer Rating in Student Group Work." *Assessment & Evaluation in Higher Education* 33 (3): 329–340.

About the authors

Marie-Christine Peeters obtained a Ph.D. in Agricultural Sciences at KU Leuven in 1987. In 1996 she moved from the Department of Tropical Agriculture of the Faculty of Bioscience Engineering to the Teaching Support Unit (TSU) of the same faculty. She is currently head of TSU and leads a team of teaching assistants and lab technicians who give the practical courses and exercises to large groups of bachelor students at the faculty. She is responsible for the practical courses in organic and inorganic analytical chemistry and coordinates the chemical project work and ITP.

Elsje Londers obtained a Ph.D. in Agricultural Sciences at KU Leuven in 2006. In 2009, she moved from the division of Crop Biotechnics of the Faculty of Bioscience Engineering to the Administrative and Support Services of the Faculty of Engineering Science. She works as a Staff Member of Education and is currently responsible for quality assurance within the study programmes of the Faculty of Engineering Science.

Wouter Van der Hoeven obtained a master degree in history, and a subsequent one in teaching education. He is now affiliated to the TSU of the Faculty of Bioscience Engineering at the KU Leuven and is currently working as a research assistant on an educational research project: 'Development, implementation and validation of an innovative coaching model for project-based learning in science and engineering education'.